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ETHERNET LOCAL AREA NETWORK

by

BRADLEY K. GEIGER

September 1988

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This paper describes LAN services available on the network, management philosophies for the LAN services, and areas of LAN administration considered important to the successful operation and maintenance of a LAN. LAN administration problems identified by users are also addressed.

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MANAGEMENT REQUIREMENTS OF THE 3COM ETHERNET LOCAL AREA NETWORK

by

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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

The Marine Corps has installed 3COM ethernet local area networks (LANs) at various sites upon implementation of the Recruit Services Management Information System. With the introduction of new technology comes the requirement to administer the network.

This paper describes LAN services available on the network, management philosophies for the LAN services, and areas of LAN administration considered important to the successful operation and maintenance of a LAN. LAN administration problems identified by users are also addressed.

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I. INTRODUCTION

The Marine Corps has installed 3Com Ethernet Local Area Networks (LANs) at various sites upon implementation of the Recruit Services Management Information System (RSMIS) in November 1987. LANs were established at each of the six Marine Corps Districts, at both Marine Corps Recruit Depots, and at Headquarters Marine Corps. Each Recruit Station was provided the necessary hardware and software to permit communication with their district's network. LANs were introduced to improve communications within and between the Marine Corps Districts, the Recruit Depots, Headquarters Marine Corps, and between the Recruit Stations and their Districts [Ref. 1:p. 2].

With the introduction of new technology comes the requirement to administer the network. LAN administration is critical in providing a high level of network availability, improving performance, and reducing the impact of failures through effective management, maintenance, and diagnostics [Ref. 2]. LAN problems can be anticipated rather than being reacted to, while problems not anticipated can be corrected quickly.

Standard LAN administration procedures are beneficial in providing continuity among Marine Corps LAN users, in facilitating LAN administration during personnel turnover, and in ensuring essential maintenance is performed.

It is the author's intent to assist the LAN user in 3Com LAN administration using 3Com's 3+ LAN software. LAN service descriptions will be discussed in Chapter II, and management philosophies in Chapter III. Areas of LAN administration considered important to the successful operation and maintenance of the LAN will be identified and examined in Chapter IV. LAN administration problems identified by Marine Corps LAN users will be addressed in Chapter V.

LAN service descriptions provide the LAN administrator or other interested personnel with a description of the main services available on the network. 3+ is the 3Com network system software. 3+ software provides file service, print service, mail service and communication services. An overview of each of the components comprising the 3+ product family will be provided. The components of the 3Com 3+ software product family are: 3+Share, 3+TurboShare, 3+Start, 3+Mail, 3+Remote, 3+Route, 3+NetConnect, and 3+3270.

Management philosophy describes in detail how each service is going to be managed without going into the actual procedures. A technical overview of the theory of operation will be provided for the 3Com 3+ product family. Network configuration, workstation configuration, and software configuration will also be discussed.

LAN administration areas considered critical to the successful application and maintenance of a LAN are identified and discussed as presented in current literature. Disk

management, system backup, security, usage monitoring, user activity monitoring, network traffic monitoring, user support, failures, and network architecture changes are crucial administration areas.

A survey (Appendix) was created to determine which LAN services were being used and to what extent and what LAN problems users were experiencing. The participants in the survey were each of the Marine Corps Districts.

The results of the survey have identified that the primary use of the LAN is to provide users with a means of exchanging information by electronic mail. Information is exchanged between each of the Marine Corps Districts and their Recruit Depot, between the Marine Corps Districts and Headquarters Marine Corps, and between each of the Marine Corps Districts and their respective Recruiting Stations. To support this use the following LAN services are utilized extensively: 3+Mail, 3+Remote, and 3+Route.

The survey has also identified several problems the users are experiencing with their LAN: trouble shooting/diagnostics, failure to receive 3+Mail, loss of route messages due to size, and insufficient listings of error messages.

This thesis will provide the user with LAN service descriptions, management philosophy and management procedures for the available services with an emphasis on the services that are used most, as identified in the survey. LAN management issues

will be addressed to include problem areas identified in the survey.

II. LAN SERVICE DESCRIPTIONS

This chapter provides a general description of each of the components of the 3+ network software. It is not intended to provide the user with a detailed explanation of the software services. Each component is characterized by the major attributes it provides.

A. 3+SHARE

3+Share is the central component of the 3+ network. It includes the necessary software to install and manage a PC network [Ref. 3:p. 3].

3+Share enables computer users on a 3+ network to share network resources. Network resources consist of directories, application programs, output devices, and disk storage space. 3+Share provides the basis for 3+ networking features such as electronic mail (3+Mail), network-to-network communications (3+Route or 3+NetConnect), and remote terminal network access (3+Remote). [Ref. 4:p. 1-1]

The primary services of 3+Share are the Name service, File service, and Print service. The Name service stores the names of all network users and servers. The File service manages the directories and files stored on the server's hard disk. The Print service manages shared network printers. [Ref. 4:p. 1-1]

3+Share provides the user with a menu driven installation, configuration and management program. The installation program provides default configurations for the commonly used server configurations [Ref. 3:p. 3]. Network configuration files can be customized by the LAN administrator to enhance network performance.

3+Share includes a menu package called 3+Menus. 3+Menus provides an interface to application programs, directories and files, network resources and network administrative commands. 3+Menus can be tailored to provide different levels of network access for users on the network [Ref. 3:p. 3]. The network administrator may want to consider a common menu for all users to reduce the amount of maintenance required during routine changes.

B. 3+TURBOSHARE

3+TurboShare enhances the performance of the 3+ network by using expanded memory to improve server performance and support more hard disks and larger capacity disks per server. 3Server3 with CacheCard can access 2MB of expanded memory [Ref. 3:p. 3]. "3+TurboShare frees-up main server memory by moving File Allocation Table (FAT) information and disk cache into expanded memory." [Ref. 3:p. 15] The space made available in the main server memory can be used to run additional services.

C. 3+START

3+Start enables 3+ PC workstations to boot directly from a network server across the network eliminating a floppy or hard disk boot [Ref. 3:p. 17]. "This feature provides an easier and faster boot than from a floppy." [Ref. 3:p. 3] However, a workstation can be booted faster from its own hard disk than using 3+Start. 3+Start requires 3+Start software and an EtherStart PROM in each workstation.

There are several advantages to using 3+Start. 3+Start diskless workstations can be used to enhance network security. Data and programs can not be copied from the network when using diskless workstations. 3+Start also simplifies network administration. 3+Start stores the startup software used by all network workstations using this feature in one central location on the 3+Start server. 3+Start delivers a copy of the startup software to the individual workstation when users start their workstations. Network maintenance is facilitated by replacing a single copy of the network software on a shared 3+Start server to upgrade all network users [Ref. 3:p. 3]. Diskless workstations also provide a cost advantage over PCs.

A disadvantage of using a diskless workstation is when the system goes down the workstation cannot be used as a standalone and productivity ceases.

D. 3+MAIL

3+Mail is a store-and-forward electronic mail system for the 3+ network. 3+Mail works with the 3+Share Name service, enabling distribution lists to be used to send mail to many users at one time. 3+Mail includes a feature called 3+Mail Minder which enables recipients to be notified when a message is received, even if they are using another program. 3+Mail supports attachment files enabling distribution of as many as 26 MS-DOS files with each 3+Mail message. 3+Mail can be accessed by remote PCs and provides automatic routing of mail messages. [Ref. 3:p. 4]

E. 3+REMOTE

3+Remote provides access to all services on the 3+ network using a remotely located personal computer, telephone line, and modem. Electronic mail can be forwarded and received, files can be transferred, and all resources on the network can be utilized. 3+Remote has line management features to reduce telephone connect time and telephone expense [Ref. 3:p. 4]. Data integrity is accomplished by full error checking on transmitted data and automatic retransmissions [Ref. 3:p. 26].

F. 3+ROUTE

3+Route provides a transparent network-to-network link to any remote 3+ network. 3+Route allows two or more remote 3+ networks to be linked together for resource sharing or electronic mail. Many 3+ networks can be connected together to

create a wide area network. 3+Route supports remote internetwork File/Print, Mail and 3+3270 service [Ref. 3:p. 23]. 3+Route uses standard telephone lines and modems to internetwork a 3+ network to any other 3+ network. All communication is completely transparent to the network users [Ref. 3:p. 4].

G. 3+NetConnect

3+NetConnect provides a high-speed, internetwork bridge between Token Ring and/or Ethernet networks [Ref. 3:p. 4].

> 3+NetConnect can be used to bridge Token-to-Ethernet, Token-to-Token and Ethernet-to-Ethernet. 3+NetConnect allows users to share network resources and send electronic mail between two separate but physically close 3+ networks. 3+NetConnect supports 3+Mail, 3+Share File/Print services and 3+3270. All resources are accessed by name as if they were located on the user's own network. [Ref. 3:p. 27]

The difference between 3+Route and 3+Netconnect is that 3+Route uses telephone lines to link networks and 3+Netconnect uses direct cable. [Ref. 5:p. 4-48]

H. 3+3270

> 3+3270 enables a workstation to access an IBM Systems Network Architecture (SNA) host for file transfer, transaction processing, scheduling and other mainframe-based applications. 3+3270 also provides mainframe access from Remote PCs and through internetwork links to other 3+ networks. [Ref. 3:p. 4]

III. MANAGEMENT PHILOSOPHY

Management philosophy for heavily used services, network configuration, workstation configuration and software configuration will be addressed in this chapter. A technical overview of the theory of operation for each of the 3+ services will be provided.

A. 3+SHARE

The primary services of the 3+Share are File service, Name service, and Print service. The theory of operations for each of these services will be addressed individually.

"3+Share File service provides controlled access to network directories and to the files and application programs in those directories." [Ref. 4:p. 2-6] 3+ uses the DOS file structure to implement the file structure of the network as sharenames. Individual directories on the network drive are equated to sharenames, to which any given user may have access. Each sharename can be thought of as a separate physical disk drive [Ref. 6:p. 72].

Users control file and directory services with the 3+Share user software program called 3F. 3+Share File service is combined with 3+Share Print service into a single executable program which runs on a server. 3+Share File service consists of both a user and server-based program. The user software

sends read, write, and other requests to be processed by the server. A user must make a request to use a service before it can be granted by the server. The server keeps track of all requests and processes them in a concurrent multi-tasking fashion. [Ref. 3:p. 6]

> 3+Share File service uses the Microsoft Redirector. This permits software applications to make file based DOS system calls over the network. DOS 3.1/3.2 provides two levels of locking capabilities on the network, file locking and byte range (block) locking. Multi-user application programs use DOS byte locking techniques to provide record locking features. [Ref. 3:p. 6]

The 3+Share Name service acts as a central directory of user and resource names for a 3+ network. The 3+Share Name service is based on the Xerox network name service protocol. [Ref. 3:p. 11]

The 3+Share Name service serves as a database to store information about network users and servers. Users and servers have three-part names, with a colon separating each part [Ref. 4:p. 2-5]. Name is the first of the three-part identification and is the user's name, server, alias group or shared resource. Domain is the geographical location or departmental designation for an organization. Organization is an umbrella for one or many domains. The Domain: Organization portion of the three-part name are optional when addressing or accessing a resource or user in your own domain and organization [Ref. 3:p. 12]. An example of a network name for a server for the 12th Marine Corps District is: SERVER1:RSMISMCD12:USMC.

The 3+Share Name service provides information about a users or network resources. 3+Share Name service is used by network services to qualify users and resources on the network [Ref. 3:p. 12]. The name service controls user's access to the various other services offered by the LAN. Typically, this is a function of the network operating systems LOGIN command. The name service also controls all of the network operating system's security functions [Ref. 6:p. 70].

> The 3+Share Print service allows users to share access to network printers and manage the print jobs being spooled to the printer. When a print file is sent to a network printer, a spool file is created on the server by the print service. The spool file is closed when the program sending the output terminates or a control code is sent. Printers run concurrently, and each printer has a despooler process. The despooler retrieves jobs from the print queue, one at a time, and prints them. Printer services are controlled by users at workstations with the 3+Share Print service user software. In addition, users can access network print resources and manage print jobs from within 3+Menus. [Ref. 3:p. 8]

B. 3+TURBOSHARE

3+TurboShare enables 3+ servers to address expanded memory for data and disk FAT caching. The file sharing performance is increased significantly by 3+TurboShare. Performance is most enhanced in networks where large files are routinely written to or read from disk, where high activity of program loads occur and where multiple users are accessing common files. [Ref. 3:p. 15]

> Caching of all FATs and most frequently accessed data is performed in expanded memory rather than the server's main memory. Large amounts of data and FAT information reside in the server's expanded memory. As the server needs access to the data in disk cache, the information is

brought into main server memory where it can be used. Performance enhancements are obtained because accessing information from expanded memory is many times faster than accessing information from disk. [Ref. 3:p. 16]

C. 3+START

A workstation equipped with EtherStart capability communicates with the Start server to find a special file called a Start volume. Then workstation's startup instructions are located in the Start volume, instead of on a workstation startup diskette. The network creates a virtual drive C: for the netstation and links it to the Start volume. The Start volume then coordinates the startup process as a diskette would. [Ref. 7:p. 1-1]

> 3+Start consists of three software programs that are used to perform workstation boot-up, user maintenance, and server processing. To use 3+Start, a user must have an EtherStart PROM in place on their EtherLink network adapter. When the user starts the workstation, the EtherStart PROM places a request to the Start program on the file server. The Start program displays a 3+Start banner then prompts the user to enter a 3+Start volume name. If the user presses a carriage return, a default start volume is used. If the user specifies a volume name, they are prompted for a password (optional) and their workstation automatically begins execution of a 3+Start volume. A 3+Start volume contains information describing the autoexec.bat file and other information which pertains to the user's startup environment. The workstation boots using this information. [Ref. 3:p. 17]

D. 3+MAIL

Mail messages are created by users at the local workstation or by users utilizing a remote PC link. Messages are sent to a 3+Mail server assigned to that user. Mail received by the server is first reviewed to determine where the recipient is

located. If the recipient is assigned to the same server as the sender, the message is received immediately. Messages to a recipient not on the same server are forwarded to that server for distribution. Messages may be routed from server to server until all addresses receive a copy of the message. If the message can not be delivered, it is automatically returned to the sender. The return to sender time period is determined by the network administrator. [Ref. 3:p. 19]

The 3+Mail administrator functions provide for the management of 3+Mail [Ref. 5:p. 2-24]:

- delete undelivered and outbound mail
- list users who have mail waiting
- list addresses of servers with pending outgoing mail
- shut down 3+Mail
- display mail statistics.

Management of 3+Mail also consists of maintenance of members and groups and monitoring of users. The administrator is responsible for the adding and deleting of groups and members to groups. Three commands are available to facilitate management of 3+Mail. The DIRM command lists the users and the number of messages waiting for each. DIRO lists the addresses of servers to which outgoing mail is addressed and total messages. STATUS displays configuration information about mail server, the number of mailboxes defined, and the number of remote users logged in. [Ref. 3:p. 23]

E. 3+REMOTE

3+Remote is a two part software module. A server-based module, 3+Remote server, is required by the server and a user-based module, 3+Remote User, is required by the user. Each remote user requires a copy of the remote software. [Ref. 8:p. 6]

A request from a remote user is received by the server and a connection is established between the remote user and the network. The telephone connection is managed by the server throughout the session. 3+Remote is managed through a modem connected to the workstation. [Ref. 3:p. 25]

Remote processing is used during the network session. All program commands are executed at the remote location and often require the transmission of large amounts of programs and data. This can be an extremely slow process, but is less expensive and is well suited for tasks like electronic mail. [Ref. 6:p. 74]

Since all information must be transferred to the remote PC before processing can take place, 3+Remote is best suited for light to medium file transfer and printer access. 3+Remote is not well-suited for heavy database and transaction processing applications. [Ref. 3:p. 25]

Loading application software from the server to the remote station is not recommended. Loading the software is a time intensive process over a modem. It is recommended that all

remote users have a copy of the software applications they will be using. [Ref. 8:p. 6]

3+Remote automatically initialize the modem to make the connection when a remote workstation is started. 3+Remote automatically dials a network and establishes a connection when applications need network access. The telephone connection is automatically disconnected and reconnected, based on the level of network access required by the remote application and a user defined inactivity timeout. [Ref. 3:p. 26]

Managing the 3+Remote service consists of managing both the server software and the remote users on the network. Management of the server operation includes maintaining telephone line and modem connections, adding modems when necessary, and removing or replacing modems when necessary. Management of the remote user includes maintenance of the Name service for each remote user and assigning a unique network number to each remote user. [Ref. 5:p. 5-23]

F. 3+ROUTE

3+Route extends communication and resource sharing beyond a single 3+ network. A dedicated communication server is not required. 3+Route uses 3+Share Name service to locate inter-network resources by name. The user is not required to know the physical or even relative location of a resource. [Ref. 3:p. 23]

Managing the 3+Route service consists of updating the 3+Route service, monitoring the use of 3+Route, and isolating problems. [Ref. 5:p. 5-22]

3+Route needs to be updated when the following items are added, deleted, or modified: a network to communicate with, a remote network's telephone number, a telephone line or port available to 3+Route, or a modem. [Ref. 5:p. 5-23]

3+Route service writes entries to a STATUS.LOG file, in the \3ROOT directory. This log file records any incoming or outgoing calls and errors that occur. The entries in the STATUS.LOG file can be used by the network administrator to monitor the use of 3+Route and to isolate communication problems. [Ref. 5:p. 5-23]

G. 3+NETCONNECT

3+Netconnect provides high-speed access to network resources between physically close networks. Network access across a 3+Netconnect bridge is transparent to the user. The user accesses applications by name as if on their own network. 3+Netconnect is used most productively in an environment where users on two different, but physically close networks, need to share a common resource. [Ref. 3:p. 27]

H. 3+3270

Access to the IBM host is provided through a dedicated 3+3270 server that communicates over a telephone line using SNA/SDLC protocols. PC users may transfer files to and from

network directories, and print jobs may be spooled to either network printers or directories. 3+3270 takes advantage of 3+Remote, 3+Route, and 3+Netconnect, which provide remote access to the server and host, and the capability to communicate and share resources across the networks. [Ref. 3:p. 28]

> 3+3270 provides network server emulation of 3274/3276 (PU Type 2) cluster controller, supporting up to 32 logical units. Each 3+3270 workstation emulates a 3278 Model 2 (monochrome) or 3279 2A (color) terminal. A model 3287 Model 2 printer is also emulated by the server to provide spooling to any local printer. [Ref. 3:p. 4]

I. NETWORK CONFIGURATION

The Ethernet network (IEEE 802.3 standards) is a baseband system that operates over coaxial cable with a transfer rate of 10 megabits per second. The 3Com Ethernet LAN utilizes a bus topology. All stations connect to the main transmission line or bus and the transmission from any station travels the length of the bus and is received by all stations.

The most commonly used cable by Marine Corps 3Com LAN users is thin ethernet. Thin ethernet is 50 ohm coaxial cable, RG58.

Several limitations exist and must be considered when adding workstations to the LAN. Segment length cannot exceed 1000 feet. Repeaters can be used to extend the maximum distance of a network through network branching. There is a maximum of 2 repeaters per network path. There is a minimum distance requirement of 3 feet of cable between nodes and a maximum of 100 nodes per segment. [Ref. 3:p. 1-8]

> When laying cable it is common to run cables along the floor at the base of walls or under desks. If cables must

> pass through walls or between floors of a building, local fire codes may require cable to be enclosed in conduit. [Ref. 9:p. 242]

Some building codes require teflon wire to be used. All cables should be labeled and a diagram of all installed cable should be maintained to facilitate cable location during routine maintenance and trouble shooting.

3Com's 3Server3 file server will support up to 100 workstations depending on what applications will be running on the network. All Marine Corps Districts were issued one 3Server3. Network expansion should consider system response degradation if software application expansion is planned as well as the increase in the number of workstations in determining the number of servers required.

J. WORKSTATION CONFIGURATION

It is recommended that workstations be configured with 640KB of memory. A hard disk should be used; otherwise, network functions that must be performed at a workstation will be slow. Each workstation must have DOS 3.1 or higher. A 3+ workstation startup diskette is needed unless the workstation can boot off the network. A network adapter card (EtherLink or EtherLink II) is required in each workstation [Ref. 3:p. 11-5]. A remote workstation must have a modem and remote user software installed.

Standardizing drives and directory names precludes the network administrator from reconfiguring applications for each user.

K. SOFTWARE CONFIGURATION

Configuration files are used on a network to customize the workstation environment and link the workstation to the network. A properly configured workstation should automatically link the user to default directories and printers. The user should only have to turn the workstation on and have a familiar menu screen at his command. All configuration commands should be transparent to the user.

Batch files or public menus can be set up by defining conventions for the relationship between shared directories and the drive letters they will be referred by. [Ref. 3:p. A-1]

3Com recommends assigning the following drive letters [Ref. 3:p. A-1]:

- Drive D: APPS directory
- Drive E: user's home directory
- Drive F: shared data directories
- Drive G: application directories.

Each workstation can have up to five configuration files: CONFIG.SYS, AUTOEXEC.BAT, START.BAT, AUTOUSER.BAT and PROFILE.SYS.

The CONFIG.SYS file loads the 3+Protocol drivers, establishes the size of ETH buffers, specifies disk buffers for local disks. It configures file handles, available network drives and specifies date/time/currency formats. [Ref. 10:p. 13-2]

The AUTOEXEC.BAT file starts the workstation, loads MINDS drivers, installs the NetBIOS interface, loads the Microsoft redirector interface, establishes the workstation network name and activates the START.BAT file. [Ref. 10:p. 13-2]

The START.BAT file logs the workstation into the network, links the netstation to the \APPS sharename, links the workstation to the user's home directory, and activates the AUTOUSER.BAT file. [Ref. 10:p. 13-2]

The AUTOUSER.BAT contains commands that define monitor type, link the workstation to additional sharenames and printers, starts MailMinder, and performs other setup procedures. [Ref. 10:p. 13-3]

The PROFILE.SYS file customizes the workstation for 3+Menus [Ref. 10:p. 13-3]. If 3+Menus is used, this file should be located in the home directory.

The above files can be created or modified using word processors or text editors. These files should be customized to specifically fit the user. Various parameters in each of the files can be set to optimize network efficiency.

Network performance can be enhanced by adding the COMSPEC command to the START.BAT file. Large applications require the reloading of DOS's COMMAND.COM as the program is terminated. COMMAND.COM is normally loaded from the drive from which workstation was started. Reloading this file from a network server is much faster than reloading it from a floppy [Ref.

3:p. A-5]. Refer to the reference manual for setting up this feature.

IV. LAN MANAGEMENT

Network management is a broad topic which consists of many activities resulting in a fully operational LAN. Nadia Mansour defines network management as "a wide range of elements necessary to plan, operate, control access to and maintain a network system." [Ref. 11:p. 24]

Is LAN management really necessary for a successful LAN? "The cornerstone to successful LAN operations is solid network management." [Ref. 12:p. 8]

LAN management consists of three basic areas: management, maintenance, and diagnostics. LAN management is a people job. It is fitting the LAN to the organization, developing applications and batch files to facilitate user interface, selling the network to the users, and training users. LAN maintenance is preventative in nature and is done to avoid catastrophes. It includes software and hardware installation, upgrades, disk backups, and anything you do to keep the LAN running. LAN diagnostics occurs after a problem has been reported. It is the trouble shooting aspect of LAN management. The three divisions of LAN management are not independent of the other. Management helps maintenance, maintenance helps diagnostics and diagnostics helps management. [Ref. 2:p. 35]

This chapter will be divided into three sections corresponding to the three areas of LAN management.

A. MANAGEMENT

A LAN manager must acquire a certain level of computer knowledge to become proficient in managing a network. The following areas are considered important [Ref. 13:p. 18]:

- Know your priorities. The LAN manager should keep the original reason for purchasing the network in focus. Use the LAN to solve the original problem.
- Know the LAN topology. Know how it is organized, how the cable is run, and how the network nodes communicate.
- Know the network operating system. Understand how and why it works.
- Know the organization's applications. What applications are used most frequently and generally how do they work?
- Know what software applications can be run on a network.
- Know the hardware. Be familiar with the inside of a PC.

As a LAN manager there are several management techniques which can be used to enhance the success of your network [Ref. 13:pp. 18-19]:

- Limit the software available. Select software applications that fulfill the needs of your organization. Place the software on your server for easy maintenance.
- Educate the users. Do not try to teach them everything at once. Get them interested and hold regular classes. Find users that are interested in certain topics and get them involved in giving classes.
- Be user friendly. Make yourself available. Do not intimidate your users. Encourage them to ask for help.
- Provide an easy to use interface. Batch files can provide easy access to user menus. A user should not have difficulty accessing a software application.
- Maintain a system log. Keep a thorough record of all system changes made.

- Develop a disaster recovery plan. Plan for the day when disaster strikes and be prepared with a thorough recovery plan.

- Monitor System performance. Know the performance capability of your LAN and check it regularly to ensure it is functioning properly. Monitor network traffic and throughput for potential application problems.

- Monitor LAN usage. Heavily use files can be distribute over different disks on a server to enhance performance.

- Monitor user activity. Know who uses what files. If problems arise malicious users can be caught and innocent users can be educated.

There are several LAN management tools on the market today to facilitate the management process. These tools provide features such as audit trails, software metering, disk management, front-ending, and traffic monitoring. Some of the products available which support the 3+ operating system are: LANSCAPE by Ncompass Software, LANSCOPE by Connect Computer, LAN SHELL by LAN Systems, and REFERENCEPOINT by LAN Systems [Ref. 14:p. 84].

B. MAINTENANCE

1. Disk Management

Disk management is necessary to provide adequate storage space for each server on the network. If sufficient space is not available the network can be slowed down and user productivity can be reduced.

Disk space is managed by monitoring the space available on each file server and making more space available when

necessary. The 3F STATUS command is used to monitor the amount of available disk space on a server [Ref. 5:p. 5-3].

At about 75% storage capacity, more space should be made available [Ref. 15:p. 42]. Additional space can be provided by [Ref. 5:p. 5-4]:

- requesting users to delete unnecessary files and/or directories.
- add a new disk.
- archive directories that are not accessed frequently.
- redistribute users and programs to servers with available space.

2. Backup

Backing up a server disk is a requirement that must be adhered to. In the unfortunate event of a disk crash or an accidental file deletion, disk backup is essential to restoration of data. Additionally, LAN performance can be increased by using a tape backup unit to backup the entire disk and then reformat the disk. [Ref. 16:p. 38]

All Marine Corps Districts have a 3Server3 tape backup unit. The backup unit uses a 60 MB tape. Two types of backups can be performed. A full backup consisting of all files and directories or an incremental backup of files changed since the last incremental backup.

A backup schedule of incremental and full backups should be created and followed. A daily incremental backup and a weekly full backup is an example of such a schedule. This schedule is dependent on LAN usage. If important data is

constantly changing, backup should be done daily. If major changes are going to be implemented to the LAN a full backup should be done prior to making the change [Ref. 17:p. 25]. 3+Backup allows the user to start backups manually or develop a schedule file on the network that automatically starts 3+Backup [Ref. 5:p. 6-1].

Critical files should be backed up on more than one tape and stored in different locations in case of disaster.

In the even of a disk crash, accidental reformat or file deletion there are utility programs which might be able to restore the files. Two such programs are Peter Norton Computing's Norton Utilities, Version 4.0 and Advanced Edition, and Paul Mace Software's Mace Utilities, Version 4.1. There is a third utility program, Disk Technician Plus by Prime Solutions which offers preventive maintenance of the hard disk to reduce or eliminate data loss or a crash. [Ref. 18:p. 89]

Norton Utilities does not work on server drives like they do on standalone PCs. Norton Utilities has problems working on the 3+ network operating system. The program will not work as long as the network operating system is loaded and the server drive is shared across the network. To get around this problem, shut the network down, reboot the server, but do not load the network operating system. Norton Utilities will now run on the standalone server. After the necessary files are restored, reboot the server and load the network operating system. Mace Utilities provides more extensive tools for data

recovery and also will not work with the network operating system loaded. [Ref. 18:pp. 89-93]

3. Network Architecture Changes

Prior to making any changes to the LAN a complete system backup should be done. Installation of new hardware and software, changing a printer configuration, updating software versions, hard disk backup and other system changes should be accomplished in the evenings and weekends or whenever the network is not in use. Keep a detailed record of all changes made to the network and exactly when they were made.

4. Security

Network security is used to restrict LAN users to what they need. Network operating systems provide security at the user, directory, file and resource level. User security for 3+ requires a user name, password, and user type. Directory security is achieved by using share names to control access with a password and access rights. Attributes are: read, write, create, delete, public, and private. File security provides the same attributes as directories with DOS file locking. Resource level security is accomplished with menus and passwords. Dedicated servers have no monitors or keyboards and diskless workstations eliminate the possibility of users copying sensitive files from the network. [Ref. 19:p. 32]

The role of the LAN administrator in providing the security of the LAN is to assign user IDs, manage passwords, and monitor audit trail reports. Basic security rules should

be enforced by the administrator. Passwords should not be written down, user IDs should not be passed or shared between users, and users should log off the system when leaving the immediate vicinity of their workstation. The administrator should also consider the physical security of the LAN by reducing access and the ability to remove computer equipment. The file server should not be located in an easily accessible area and should be in a locked room if possible. Workstations and network peripherals should be bolt-mounted to immovable objects. [Ref. 20:p. 30]

C. DIAGNOSTICS

1. Troubleshooting

When a LAN problem occurs you need to have a general plan formulated on how you will begin troubleshooting.

> A possible series of steps to follow would be: 1) define the problem, 2) collect the facts, 3) determine what was different before and after the problem occurred, 4) select the most probable cause, and 5) follow up. [Ref. 12:p. 8]

A series of logical steps performed in the proper sequence will assist the LAN administrator in correctly diagnosing the problem and in taking the appropriate action.

> The troubleshooting process is not complete until: 1) the solution has been verified as a fix to the problem, 2) the solution has addressed the root cause, and 3) the problem and its resolution has been properly documented. [Ref. 12:p. 8]

The solution should be tested under normal working conditions to verify the proper remedy has been applied and to preclude a reoccurrence of the same problem.

2. Troubleshooting Tools

An arsenal of troubleshooting tools is not necessary to locate your system problem. Several tools have been found extremely valuable in aiding the administrator in successfully solving the problem.

- Ohmmeters. An ohmmeter is used to locate cable problems. "If the impedance reading matches the rated impedance of the cable, you do not have a cable problem. If the reading does not match the impedance, the cable has a short, crushed conductors or a break." [Ref. 21:p. 64]

- Outlet tester. A piece of LAN equipment plugged into an improperly grounded outlet can sometimes adversely effect equipment over the entire network [Ref. 21:p. 64].

- Oscilloscope. An oscilloscope can help detect the existence of noise or other disturbances on the wire. Outlet problems can be identified [Ref. 21:p. 64].

- Time domain reflectometer (TDR). "Many TDRs can detect the location of a cable fault within a few feet." [Ref. 22:p. 70] The 3Server3 is equipped with diagnostics that include a TDR test. In addition to the TDR test, the 3Server3 also provides error messages to aid in diagnostics. It is recommended that a backup be performed prior to running any server diagnostics [Ref. 21:p. 73]. "The LanScanner from 3Com is a small, inexpensive, hand-held, battery powered TDR that allows the user to use menus to select the wire type and choose a desired test function. LanScanner can perform a DC Loop test, noise detection, and cable scanning using TDR to diagnose cable problems." [Ref. 21:p. 66]

- 3Station Diagnostics. The diagnostics menu can be accessed from a 3Station to provide diagnostic tests. One of the tests available is the loopback test where a workstation sends a message to itself. If the packet is not received intact, there is a problem, usually with the interface card. [Ref. 21:p. 67]

V. PROBLEMS AND RECOMMENDATIONS

A. PROBLEMS IDENTIFIED

This chapter will concentrate on two main topics. Problems identified by 3Com LAN users (Appendix) will be addressed and recommendations to assist in LAN management and network performance will be provided.

The following problems have been identified: a need for troubleshooting and diagnostic tools, mail sent/not received, route messages lost due to size, a more complete listing of error messages, error accessing Name server, and connecting as a remote during peak use hours.

1. Troubleshooting and Diagnostic Problems

The troubleshooting and diagnostic problem has been addressed in the LAN Management chapter of this text. Theories and tools for both of these subjects are discussed.

2. Mail Sent/Not Received

Mail sent/not received could be caused by several factors. If mail is attempted to be sent from a remote station and a mail server error message is received, follow the appropriate action described in the 3+Messages Reference Guide and resend the mail. Typical problems encountered are an unrecognized destination caused by user error, a mail server error retrieving the message (some mail may have been lost), and a previous session did not terminate correctly.

A unique network number is assigned to each remote user. This number allows the network services to maintain a single logical connection with the remote user. If this number is not unique two or more remote users could access the network using the same number with unpredictable results [Ref. 5:p. 4-40].

The MSPROC parameter specifies the maximum number of simultaneous Mail server processes that the server can handle. With a mail intensive environment experienced by Marine Corps LAN users, this number of mail server processes may need to be increased [Ref. 10:p. 11-3]. Refer to the 3+ Network Tuning Guide for more information.

It should be noted that remote users take longer to receive and send mail than users connected directly to the network. This time can be magnified during periods of intense use.

Mail is not immediately sent from a remote station. The mail server waits a preset number of sleep cycles before forwarding mail to servers on other networks. This sleep cycle is set with the MSFRSLEEP parameter [Ref. 10:p. 11-6]. Refer to the Network Training Guide to adjust this parameter.

3+Mail which cannot be delivered is automatically returned to the message sender. The network administrator determines the return to sender time period. [Ref. 3:p. 19]

3. Lost Route Messages

3+Mail permits messages to attach up to 26 DOS data, program or text files, of 32MB each and a total message length not to exceed 20KB [Ref. 3:p. 22]. Exceeding this limit may cause unpredictable results to include loss of messages. The STATUS.LOG file created by the 3+Route service can be used to monitor the use of 3+Route and to isolate communication problems. This tool may be helpful in locating the problem of lost route messages.

Batch files could be written to produce a written report to be used by management as a management tool to ensure messages are successfully sent.

4. Complete Error Listing

The 3+Messages Reference Guide provides an extensive source of errors and status messages for both 3Com hardware and software. A recommended course of action is provided with the error meaning. Any errors not covered in this manual should be documented and appended to the manual for future reference. Communication with other LAN users could be a source of problem solving in addition to 3Com.

B. RECOMMENDATIONS

The following recommendations are made based on the survey conducted at each of the Marine Corps districts.

1. Disaster Recovery Plan

Five of the six districts surveyed indicated they do not possess a disaster recovery plan. A disaster recovery plan should be developed to assist the LAN Administrator in a series of steps necessary to recover the network and return services to the user as soon as possible.

2. Backup Schedule

Full server backups are performed weekly at four of the districts, daily at one of the districts, and twice weekly at one district. Three of the districts perform incremental backups daily while the remaining three districts do not perform incremental backups. Evaluate current backup schedule and consider using full backups supplemented with incremental backups. Important data should be backed up regularly.

Four districts do not maintain more than one copy of backup tapes. Five districts store backup tapes in the same room as their LAN. Additional copies of important data should be maintained and stored in a separate location if possible.

3. LAN Change Log

Two districts do not maintain a record of system changes and network problems. All software and hardware modifications to the network should be recorded in a log with the date and time the change was made, and who made the change. In addition, the log should contain all problems encountered and action pursued.

4. Add Software Applications

One district utilizes a database software application on their LAN. All other districts have now software applications available to users on the LAN. The main objective of the RSMIS is to provide communication between users. However, software applications such as wordprocessing, database, and/or spreadsheet could be added to the LAN to enhance office productivity and take full advantage of LAN capabilities.

5. LAN Administrator Training

Two districts have LAN administrators with no formal LAN training. Formal training of new administrators is crucial to providing a solid base for good administration. Formal training of users should also be considered. A regular schedule of in-house training is encouraged to develop and maintain competent skills.

6. Bulletin Board

Computer bulletin boards provide an excellent database for problem solving. Two types of bulletin boards would be useful to the LAN administrator. An internal bulletin board within RSMIS would be helpful to contribute toward standardizing the networks and solving problems which may have previously been solved by another RSMIS user. A bulletin board external to RSMIS would provide a larger database for problem solving. Bulletin boards provide a good communication media with the outside world.

VI. CONCLUSIONS

This thesis has addressed management issues considered important to the successful operation and maintenance of a LAN. LAN service descriptions and theories of operation were provided to assist Marine units using 3Com Ethernet LANs. Problems identified by Marine LAN users were also discussed.

Management areas considered critical to the effective operation of a LAN are: disk management, system backup, security, usage monitoring, user activity monitoring, network traffic monitoring and network architecture changes. It is important that the LAN administrator becomes knowledgeable with the specific hardware and software on the LAN to anticipate problems before they occur and correctly diagnose the proper remedy. A basic supply of troubleshooting and diagnostic tools should be acquired.

LAN service descriptions provide the user with a description of the main services available on the network. The service descriptions provided a summary of: 3+Share, 3+Turboshare, 3+Start, 3+Mail, 3+Remote, 3+Route, 3+Netconnect, and 3+3270.

Theory of operation and management philosophy was provided for each of the services, network configuration, workstation configuration and software configuration.

A survey was prepared with each of the Marine Corps districts identifying their system configuration, LAN use, and LAN problems they encountered. The survey revealed the LAN is mainly used as a communications medium for the Marine Corps districts, their remote stations, and Headquarters Marine Corps. The 3+Mail facility provides the electronic mail service. The 3+Route and 3+Remote facilities are also heavily used.

Problems identified by the districts were troubleshooting/ diagnostics, failure to receive 3+Mail, loss of route messages due to size, and a need for a more comprehensive listing of error messages. Each of these problems was addressed in this thesis.

APPENDIX

3COM LOCAL AREA NETWORK SURVEY
(LAN Administrator)

HARDWARE

File Server

1. What type of server do you use on your LAN?

   o 3COM 3Server3 o 3S/200 o 3S/400 o other

   6

2. How many servers are on your LAN?

   o 1 o 2 o 3 o other(___)

   5 1

3. If you are using a PC as a server, what is the storage capacity of the hard disk?

   o less than or equal to 40mb o greater than 40mb

   1

Workstations

4. Approximately how many workstations are on your LAN?

   o 10 o 20 o 30 o 40 o more than 50

   2 3 1

5. What percentage of your workstations have hard disks?

o 0% o 25% o 50% o 75% o 100%

6

6. What percentage of your workstations have modems?

o 0% o 25% o 50% o 75% o 100%

2 3 1

7. What percentage of your workstations have 3270 emulation?

o 0% o 25% o 50% o75% o 100%

5 1

Printers

8. Approximately how many printers do you have in your LAN?

o 3 o 5 o 10 o greater than 10(___)

4 1

9. What percentage of your workstations have their own printer (i.e., printer is not connected to a server)?

o 0% o 25% o 50% o 75% o 100%

2 4

Cable

10. What type of cable is used in your LAN?

o thin ethernet o thick ethernet o other

5 1 (TEFLON)

11. What is the maximum distance between a server and a workstation?

o 25 feet o 50 feet o 75 feet o 100 feet or greater

1 5

SOFTWARE

File Server

12. What network software do you use?

o 3+ o Ethershare o other(_____)

6

13. What applications are available on the LAN?

o WordPerfect o Wordstar o DBASE3+ o R:Base System V

1

o Lotus 123 o other(_____)

4 (NONE)

14. Are any of the data files accessed simultaneously?

o yes o no

3 3

15. If you use 3+ network software, which of the following products are available on your network?

o 3+Turboshare o 3+Start o 3+Mail o 3+Remote

2 6 6

o 3+Route o 3+Netconnect o 3+3270

6

16. Which of the following 3+ network software products do you use extensively?

o 3+Turboshare o 3+Start o 3+Mail o 3+Remote

6 6

o 3+ Route o 3+Netconnect o 3+3270

6

SECURITY

17. Who has access to the server (load new applications trouble shoot)?

o LAN administrator o alternate o others

6 2

18. What directories can users write to on the network?

o all o their own only o their own and some others

1 4

BACKUP

19. What media do you use for LAN backup?

    o DEI 600L data cartridge (3Server3 tape backup unit)

    6

    o DC600 tape cartridge o disk to disk o WORM cartridge

    o removable disk o floppy disk o other(_____)

20. How often do you perform a full server backup?

    o daily o every other day o weekly o other(_____)

    1 4 1 (TWICE/WEEK)

21. How often do you perform an incremental server backup?

    o daily o every other day o weekly o other(_____)

    3 3 (NEVER)

22. Where do you store your backup tapes or disks in relation to the LAN?

    o same room o different room o different building

    5 1

23. Do you have more than one copy of backup tapes or disks?

    o yes o no

    2 4

24. Is the backup copy stored in a different location than the original backup?

o yes o no

6

25. Do you have a disaster recovery plan?

o yes o no

1 5

ADMINISTRATOR

26. Are you the designated LAN administrator at your unit?

o yes o no

6

27. Do you have any previous LAN experience?

o yes o no

6

28. Have you received any formal LAN training?

o yes o no

4 2

29. Do you have any additional duties?

o yes o no

6

30. If you have additional duties, approximately what percentage of your time is devoted to additional duties?

o 25% o 50% o 75%

1 5

OTHER

31. Does a LAN administrators manual or SOP exist at your unit?

o yes o no

2 4

32. If a manual exists, what is lacking in it?

ERROR CODES LACKING

33. What information has been helpful in the manual?

SYSTEM OPTIMIZING DATA

34. If a manual does not exist, what topics would be helpful?

USER, REMOTE AND 3SERVER3 ERRORS,
TROUBLE SHOOTING/DIAGNOSTICS, CONDENSED EASY TO UNDERSTAND VERSION OF 3COM MANUALS

35. What LAN problems do you most often experience?

REMOTE USERS UNABLE TO CONNECT TO SERVER, COMM ERRORS, LOSS OF ROUTE MESSAGES DUE TO SIZE

36. Do you maintain a system log for system changes and network problems (looseleaf notebook or automated)?

o yes o no

4 2

37. What problems does your LAN solve?

o resource sharing o communication o standardize s/w

3 6

o other(_____)

38. Do you anticipate future expansion of your LAN?

o none o moderate o extensive

2 3 1

39. Please provide a point of contact and autovon number for your unit if additional questions are necessary.

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